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TECHNICAL MEMORANDUM

M53-21-2

- INFINITY AIMING POST -
EXAMINATION OF UNITED KINGDOM PRISM
TYPE PARALLELSCOPE
BY W. E. HOLLIS

11 JUNE 1953

Fire Control Instrument Group
FRANKFORD ARSENAL
PHILADELPHIA, PA.

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Optical Design Branch
Research and Development Division
Ground Weapons Department
Fire Control Instrument Group
Frankford Arsenal, Box 7989
Philadelphia 1, Pa.

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INFINITY AIMING POSTS
EXAMINATION OF UNITED KINGDOM PRISM TYPE PARALLELOSCOPE

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11 June 1953

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INFINITY AIMING POSTS
EXAMINATION OF UNITED KINGDOM PRISM TYPE PARALLELOSCOPE

ABSTRACT:

This report contains a description of a United Kingdom Prism Type Parallelloscope giving overall weight and dimensions as well as the dimension and optical quality of the prism therein contained. No attempt has been made to assess the performance of the instrument inasmuch as performance tests on same are scheduled by Army Field Forces. Comments are given regarding the modifications to the instrument which this Arsenal has made because of the fact that it was received in a damaged condition. Finally, a conclusion is drawn regarding a similar instrument which could be produced which would be more durable, have better image quality and be produced in quantity.

I. AUTHORITY

The work described in this report was carried out under authority from Office, Chief of Ordnance contained in letter file OO 413.68/69, Subject: Infinity Aiming Posts, dated 3 March 1953.

II. INTRODUCTION

1. In conjunction with the program of Tripartite Standardization Army Field Forces has obtained on loan from the United Kingdom one Prism Type Paralleloscope. Permission was granted for a ten day delay en route of this instrument in order that study of same might be made at Frankford Arsenal.

2. The Optical Design Branch, Research and Development Division, Ground Weapons Department, FCIG, has been assigned the responsibility for the examination of the technical features of this instrument and this report is a result of that examination.

III. DISCUSSION

1. The United Kingdom Prism Type Paralleloscope weighs 17 pounds and consists of a case 33¼ inches long by 5½ inches wide by 3½ inches deep in which is mounted a 90° prism 30 inches long by 2-1/16 inches wide by 1-1/32 inches deep. (See Figure 3)

2. The instrument may be mounted on two steel pickets which are clamped to the instrument as shown in figures 1 and 2. The pickets weigh 29 pounds, are approximately 1 inch in diameter and 29 inches long. The pickets may not be driven into the ground more than 9½ inches because of a circular plate rigidly attached thereto.

3. The instrument construction is illustrated in the sectional view of Figure 3. The prism is mounted in a bed of sponge rubber which in turn is cemented to a steel support. The steel support is attached to the outer steel case by means of a sponge rubber pad cemented both to the support and to the case.

4. Upon receipt of the subject instrument at this Arsenal, it was found that the prism was in no way constrained to remain in place in its bed. The longitudinal motion which this lack of constraint permitted had allowed the prism to strike the ends of the steel casing causing extensive damage to the ends of the prism. Since the prism was not constrained in place, it was possible to remove it and inspect it as an individual item. Inspection reveals that the prism is made of a low grade of glass, probably rolled plate, containing imperfections such as bubbles, seeds, and striae. The prism has not been "polished out", inasmuch as a gray color is evident on the polished surfaces. The image quality of the prism is extremely poor. Resolving power measured at the extremes of the prism and at the center is 129 seconds. Theoretical resolving power for a prism of this aperture (1.25 in) would be approximately 4.4 seconds. Considerable astigmatism is evident particularly in the horizontal meridian and image doubling was noted. Although these factors are detrimental to good optical imagery, it is felt that the intended performance of this instrument will not be seriously effected thereby. The deviation error (see Figure 4a) of 10 minutes serves to limit the distance from the Paralleloscope at which a viewing teloscope may be placed. (See Appendix I) The pyramidal error (see Figure 4b) of five minutes causes an azimuth displacement of the incident beam which may be compensated for at initial set up of instrument provided it is constant along the prism face.

5. In order to insure that no further damage would be incurred by the instrument either in transit or in test, the prism has been secured within the case by means of two metal straps at both ends of the prism. Blocks of rubber have been placed at each end to prevent shifting. It is pointed out that pressure of the straps on the prism will probably introduce azimuth errors. In an attempt to avoid this condition, the straps have been adjusted so that very little pressure is exerted on the prism. A test of the instrument in the manner of its use was made to determine the azimuth error present after addition of the straps. The results of the test indicated that the pyramidal error of the prism varied by approximately 4.5 minutes across the prism face.

IV. CONCLUSIONS

After examination of this instrument, it is concluded that a similar instrument could be designed which would have as its principal component a series of plane mirrors or prisms rigidly mounted using latest metlbond techniques developed at this Arsenal. Such an instrument could be manufactured with requisite optical quality and durability and further, it is possible that the design could be such that the instrument would "fold up" when not in use.

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APPENDIX I

Investigation of Effect of Prism Deviation on Maximum Viewing Distance

1. The deviation error (E) present in the prism under discussion serves to limit the distance from the Paralleloscope at which a viewing device may be placed without the returning ray missing the entrance pupil of this viewing device.

2. To illustrate a method which may be employed to determine this distance we will replace the Porro type prism by a Porro type reflector. The deviation error (E) may be considered as being the result of a rotation of one of the reflector mirrors with respect to the other by an angle of E/2.

3. In order that an illustrative example may be given, the following condition will be assumed initially:

a. EP of Viewing Telescope = .66 inches

b. Point source of light so located that if the Porro reflector were perfect the image of the source would appear to be on the optical axis of the viewing telescope.

c. The space coordinates of point B (see Figure 5) remain essentially unchanged for small values of E/2.

d. Deviation error (E) equals 10 minutes equals .00291 radians.

4. The results of the computation based on the above assumed conditions reveal that the distance between the viewing device (Panoramic Telescope) and the Paralleloscope should not exceed 15 yards.

5. It is pointed out that other sets of initial conditions which might be assumed will give rise to different results; however, the general method of attack is applicable in all cases.

6. It is further pointed out that a variation in the distance between light source and the optical axis of the viewing telescope will allow compensation for the prism deviation error.

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From the geometry of the accompanying figure the following equations result:

(1) From triangle AED $\tan A = (y+.33)/[D + (D+1.25)\cos E]$

$= (y+.33)/(2D+1.25)$ $\cos E \cong 1$

(2) From triangle ABC $\tan A = .955/(D+.625)$

(3) From triangle O_2FE $y = (D+1.25)\sin 10'$

Equating equations 1 and 2 together and multiplying equation 2 by the quantity 2/2 we obtain after simplification,

$$y+.33 = 2(.955)$$
$$y = 1.58$$

Substituting this value of y into equation 3 we solve for D and find

$$D = 1.58/.00291 - 1.25 = 541.7 \text{ inches} = 15 \text{ yards}$$

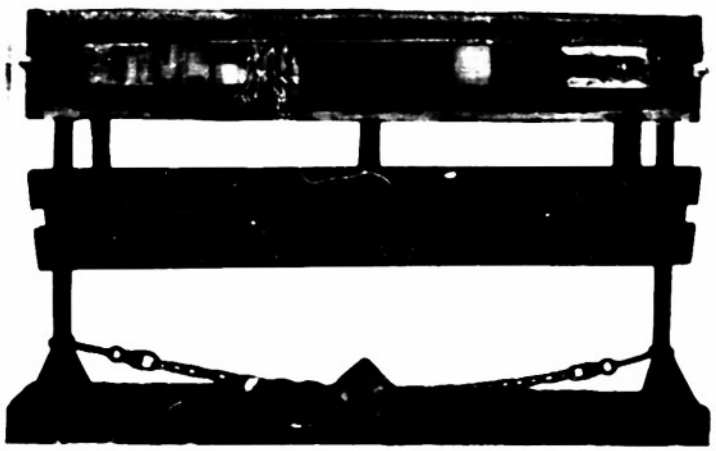
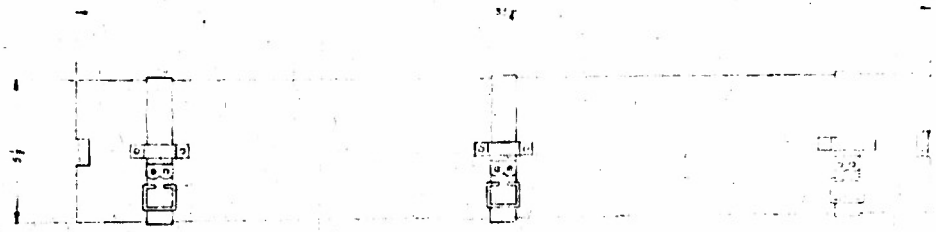


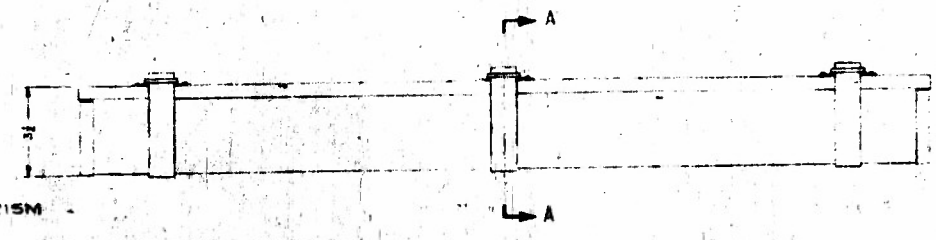
FIG. 1

FIG. 2

NEG. #23832 6-16-53 FRANKFORD ARSENAL ORD. CORPS

UNITED KINGDOM PARALLELOSCOPE.



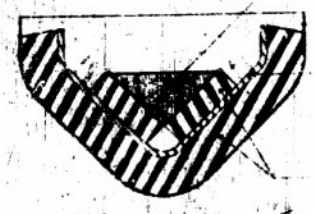


PRISM

STEEL CASE

STEEL SUPPORT

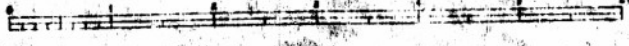
SPONGE RUBBER



SECTION A-A. COVER REMOVED

SCALE 1:1

PRISM DETAIL



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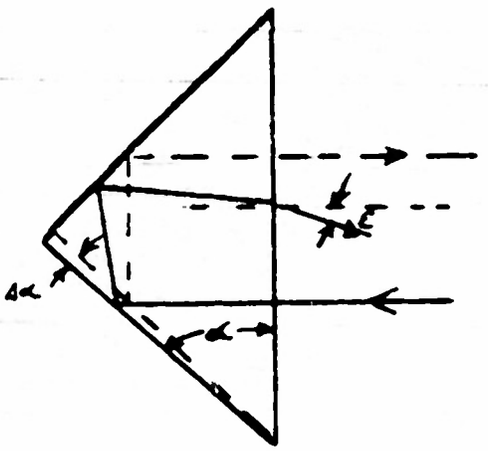

FIG. 4a (END VIEW)
PRISM DEVIATION ERROR, E, MEASURED IN THIS PLANE
DOTTED LINE INDICATES IDEAL PRISM (E = 0)

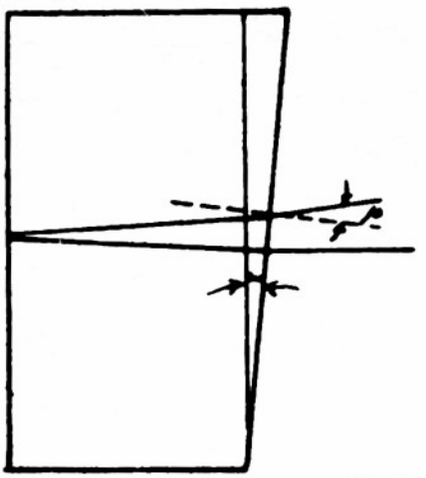

FIG. 4 b (PLAN VIEW)
PYRAMIDAL ERROR, P, MEASURED IN THIS PLANE

W. W. H
11 June '69

NOTE: $O_1O_2 = 1.25$ INCHES.
COORDINATES OF POINT B (.625, .625)
FROM PRISM DIMENSIONS.

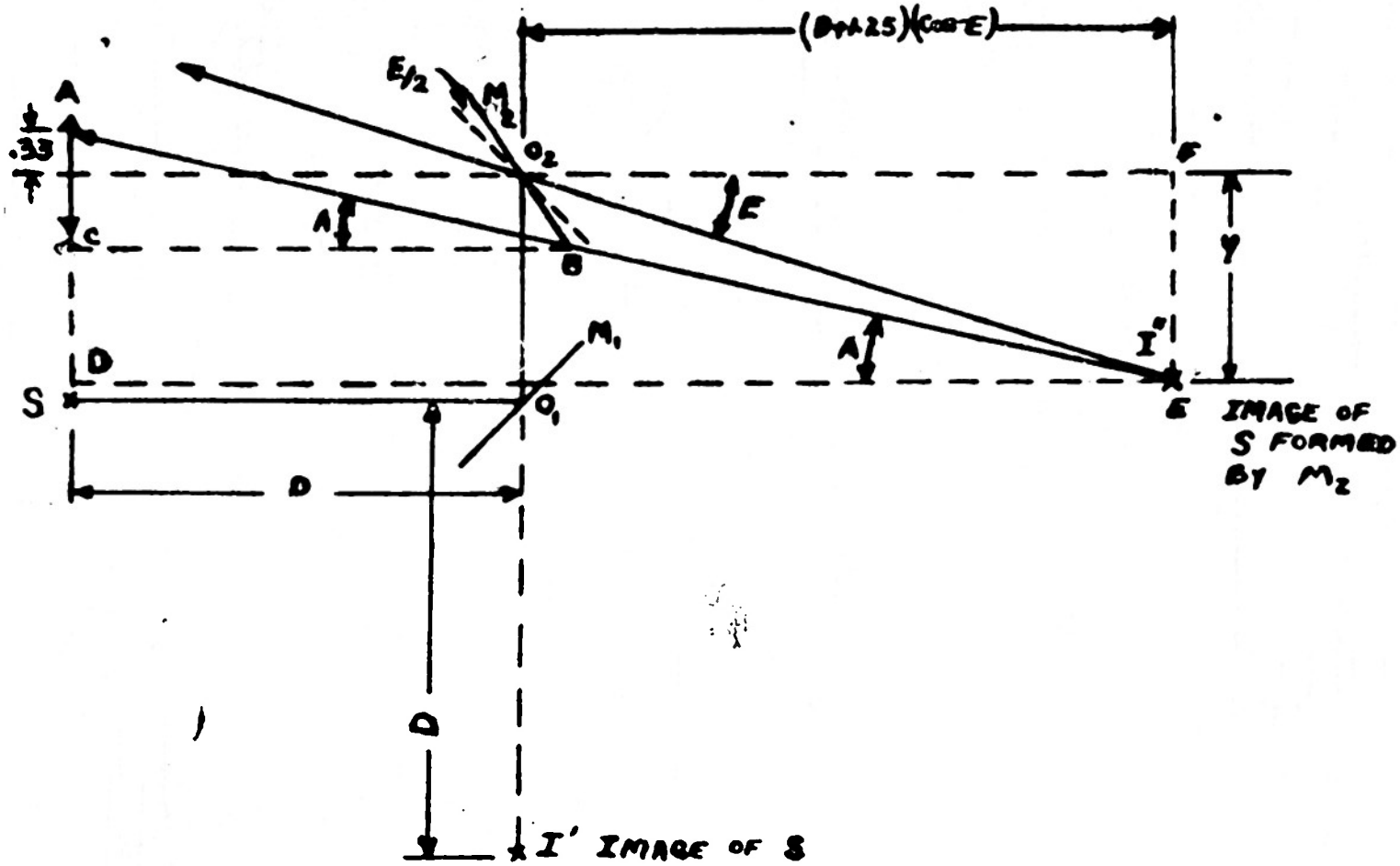

FIG. 5
M63-21-2